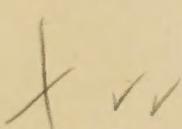


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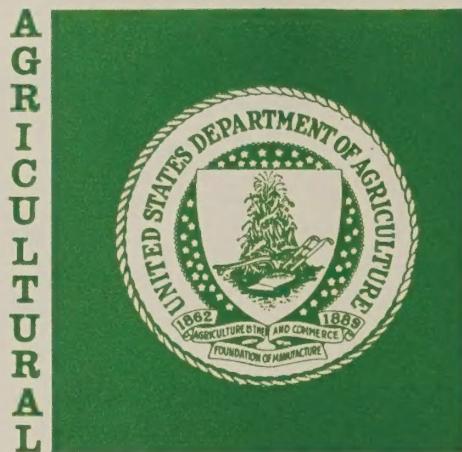
of Specific Irrigation Projects

in

TUNISIA

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AGRICULTURAL DEVELOPMENT OF SPECIFIC IRRIGATION PROJECTS

IN TUNISIA

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Prepared For

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SCOPE OF STUDY

The Irrigation Survey Team's terms of reference were concerned specifically with Tunisia's agricultural land-water development plans for: the 50-well program; the El Haouaria project; the Oued Nebaana project; and the Upper Medjerda project.

BACKGROUND

Tunisia is a small country about the size of Louisiana, having some 4.5 million people with an ancient and colorful history. It is strategically located near the center of the Mediterranean coast of North Africa. The semi-arid to arid climate divides the country into three broad agricultural zones: the northern mountainous area with seasonal rainfall from 16 to 40 inches, the central plains with 8 to 12 inches and the southern oasis or desert portion with 4 inches or less. This natural precipitation is not only seasonal, in that most of it falls in the winter, but is highly variable resulting in destructive flash floods and reoccurring years of severe drouth. The agricultural hazards of such a climate have been aggravated by centuries of overgrazing and exploitation of the natural cover. These factors plus dry farming methods have resulted in a land of bare and eroded mountains, silted waterways, and highly variable -- often saline -- alluvial soils.

In spite of the loss of the pre-independence-guaranteed French markets, the exodus of the skilled colon farmers and the nationalization of some 2 million acres of the remaining European-held farm lands in 1964, the agriculture sector of the economy provides nearly 30 percent of the gross domestic product, employs 70 percent of the population and accounts for 65 percent of the export earnings. Nevertheless Tunisia is a food-deficit country with a very unfavorable balance of trade due in a large part to food import requirements.

Within an overall 10-year Plan or Perspective 1962-71; the Tunisian Government has provided for agricultural growth. The second phase, commonly referred to as the Four Year Plan 1965-8 is optimistic under present conditions and past history. In brief, the Four Year Plan projects an increase in the export of fresh and canned vegetables, fruits and some olive oil, but directs the principal production effort at import substitution by the promotion of a program of self-sufficiency. While the plan puts a substantial portion of the total national investment into agriculture, nearly one-half of it is for irrigation development. It recognizes the shortage of trained manpower and indicates that less than one-half of these needs will be met by 1968 but appears to discount the production inputs and individual farmer incentives required.

The Government of Tunisia is putting forth a major effort in primary and vocational education by utilizing a complex of domestic and foreign facilities but it is, and will remain for the foreseeable future, woefully short of university trained agriculturalists. It has a rather imposing number of agronomic and horticultural stations but these are frequently on small specialized plots primarily concerned with seed production or plant propagation under limited technical direction or management.

A National Agricultural Bank provides long and medium-term loans as well as short-term credit to private farmers and cooperatives. The interest rates vary from 1-1/2 to 5 percent according to activity being financed. To date some three-fourths of its funds have been absorbed by the agricultural processing and marketing sectors of the economy. The bank also serves as agent for the Government in administering a complex program of direct subsidies of varying amounts under varying conditions to both private farmer operators, cooperative farms or combinations of both.

There is a great dependence upon cooperatives to provide the production and marketing services as well as the land management and water control. The degree of governmental control over individual cooperatives varies from complete ownership and management to the provision of supporting assistance or special services for private owner operators.

The farm cooperatives fall into three broad types:
(1) The production unit cooperatives through which the more than 500 state-operated farms are to be broken into small units and sold to individual owners although managed as an integrated unit; (2) the polyculture cooperative usually made up of tribal-owned and former religiously controlled lands; (3) the standard service cooperatives providing necessary services to individual communities or commodity groups. The irrigation projects may be serviced and/or controlled

by one or more of these types.

One of the weaker links in the institutional structure is the adult education (extension) service. Generally an area development plan presupposes one or more agricultural technicians, called monitors, resident in the area to personally advise, control and/or direct the activities of producers. At the moment there appear to be some 100 "engineers" and 400 sub-university trained monitors assigned to such activities. However, these men are employees of one of some 9 different specialized or commodity sections or semi-autonomous organizations within the Agricultural Secretariate. As recently as February 15, 1966, an Agricultural Seminar held in Tunis restated a recommendation that the various extension-type groups be brought into a single coordinated field service.

The outside financial and technical aid being extended to Tunisian agriculture is certainly diverse with a variety of U.N. Special Fund and FAO technical assistance projects, U.S. AID capital and technical projects plus Food for Peace and Peace Corps contributions and numerous other bi-lateral efforts of varying magnitude, duration and purpose.

Specific large scale irrigation project development and actual operation experience is limited to the partially developed Lower Medjerda project. This development was started as a Marshall Plan project and is now in partial operation as a semi-autonomous legal entity. While many of its activities are still being carried on with foreign technicians and there is still much development work to be done, it has served and certainly should continue to serve as a valuable guide to future irrigation and land reform activities, and to technical and managerial manpower requirements for those activities.

TECHNICAL ASSISTANCE REQUIREMENTS

Each of the four projects differs in many respects from the others. Nevertheless, there are certain technical and administrative manpower needs common to all of the projects. For example, in each project certain kinds of technicians and specialists will be needed to guide and direct the development and organization, and to help in the training of Tunisians. Common to all such projects is the need for specially trained personnel such as agronomists, horticulturists, irrigation engineers and soil scientists. There is also a common need for attention to watershed protection and range management in lands associated with each project, and for cooperative administrators, office managers, marketing specialists, warehousemen, etc.

In the present state of development the GOT recognizes the necessity for such technicians, and the great shortage of qualified local personnel to meet these needs. The GOT has begun a dynamic program of education and training to help meet this need. It is allocating 30 percent of its budget for educational purposes, of which agriculture gets a larger share than in most developing countries.

Within the present educational system and the existing agricultural schools and training centers the GOT should be able to accomplish training within a reasonable time of an adequate number of clerks, bookkeepers, equipment supervisors, warehousemen, etc. But candidates for supervisory positions such as cooperative administrators, office managers, as well as land and water use technicians will need to have a university level education plus applicable previous work experience and/or additional special training. Persons for these positions should be selected with care but identified as promptly as possible, and necessary special training arrangements made well in advance of project operations. With the present limited educational facilities in Tunisia many of these key people will need to be given a six-month's to one year's training abroad. The length of the specialized training would depend upon the individual's previous academic training, work experience, aptitude, etc. The specialized training should include techniques unique to the positions for which these persons were chosen and include emphasis on overall administration, group direction and training of staff members.

Phases of Project Development

The team recognizes that there are at least three phases of project development:

1. The national socio-economic phase, (or how the project is related to the national objectives and production goals), budgetary limitations, land settlement problems and similar items of broad national import;
2. The engineering phase involving determination of amount and quality of water, design and construction of principal facilities, including housing, schools and community centers, and related physical factors; and
3. The agricultural production and marketing phase, which requires bringing the land, water and people together into an efficient producing and marketing unit. This phase, while often considered last, is the "pay-off" of all foregoing effort.

Moreover, it also is noted that the limitations on the role of foreign advisers changes with each phase. In the matters of national planning they can only advise, for the responsible government must make the final decisions. In the engineering phase they may assume major responsibilities and actually perform and/or direct activities.

In the third, or the on-the-project production and marketing phase, foreign technicians should avoid assuming the actual direction of farmers' activities limiting their participation to advising with Tunisian officials and on-the-job training of Tunisian technicians. This fact underscores the need for, and importance on the project of Tunisian counterparts. At least one national should be selected and assigned to work with, and receive training by, each of the foreign specialists working on the projects. It is believed that the Ministry officials appreciate this and the team was encouraged to find that in the lower Medjerda development, approximately 30 Tunisians are working with some 50 foreign technicians.

In accordance with the terms of reference set forth at the beginning of this report, the following comments and appraisals of technical manpower needs are concerned only with the third, or production, phase. Moreover, each suggestion is based upon the assumptions that:

1. The GOT either has or will secure technicians to survey and establish individual land parcels and design and supervise the construction of basic irrigation and drainage facilities, community centers, cooperatives facilities, and essential farm structures.
2. In the near future Tunisia must depend upon sub-professional and vocationally trained technicians to perform much of the field work and maintain contact with farmers.
3. Settlement on irrigated land will require each selected farm family to make radical changes in their way of life as well as learn new farming techniques.
4. The irrigated portion of an area or community will be so operated that it becomes an integral part of the whole watershed or community.

5. Credit availability to farmers and co-ops and credit facilities, both local, central and mobile as now available in established irrigation areas will be provided in the new irrigation projects.

6. The four projects considered by this team are only a part of the overall Tunisian irrigation plan.

Reference is made to the need for research for determining the most advantageous crops to be produced on the irrigation projects, disease control, etc. Such research is now done only to a limited extent, but the team was pleased to learn that steps are being taken to expand these efforts. The results of such an expansion should be of benefit not only to the proposed irrigation projects but to the entire Tunisian agricultural effort. The recommendations referred to in this report with regard to the need for additional research should be considered as additional to, and in support of, the present research program.

The team understands that the socio-economic problems referred to in the initial phase of project development, particularly the international aspects of marketing, and the research necessary to support the production phase are being given detailed attention by others and therefore these aspects have not been dealt within this report. We wish to underscore the need for such technical support not only because it is vital to the success of the specific projects reviewed herein but because it is a necessary ingredient to national agricultural development. It should be emphasized that the technical assistance discussed in this report is with reference to irrigation project development and therefore would be in addition to, and in support of, rather than in lieu of such research and marketing services.

National Technical Team

The team understood and accepts the premise that the irrigation projects would be developed and operated as an integral part of the GOT administrative system (National Ministries, Gouvernorats, Territorial Delegations, etc.) rather than by establishment of a separate legal or autonomous entity for each of the irrigation projects. The following recommendations as to technical manpower support are predicated on that understanding.

It is believed that the most urgent of the external technical manpower needs is for a national office level group of technicians who would be headquartered in Tunis, attached to the various divisions within the GOT Ministry of Agriculture and be concerned with all phases of the agricultural development, administration, settlement and operation of these and similar irrigation projects.

Such a national headquarters group should include 9 technicians with the following specific skills:

A Chief of Party with experience in the administrative coordination and direction of operating agricultural programs.

An agronomist with experience in semi-arid agricultural production techniques, including irrigation.

A horticulturist with broad experience in citrus and deciduous fruit production.

An agricultural or irrigation engineer experienced in methods of water application, land leveling, layout of farm irrigation systems and operation and maintenance of such systems.

A soil scientist experienced in soil mapping and land classification and interpretation.

A range management specialist experienced in pasture use, grazing control and range conservation.

An animal husbandry specialist experienced in production and feeding of range cattle and sheep.

An agricultural economist experienced in farm management and marketing techniques.

A specialist in the organization, administration and operation of agricultural cooperatives.

It is especially important that the GOT assign a Tunisian counterpart technician to each member of this national group. Moreover, as other trained Tunisians become available they should be assigned as additional counterparts for additional on-the-job training. University-trained people should be selected and, wherever possible, they should be rotated between different positions in disciplines in which they have academic training. Undoubtedly, there are some university-trained Tunisians that could be assigned as counterparts to this national

group from the beginning. Moreover, the GOT's program of training Tunisians in these specializations should be stepped up so that by the end of the third year of the program at least 20 Tunisians will have been sent abroad for specialized training in these particular disciplines. In other words, a minimum of seven Tunisians should be sent abroad each year for specialized training in the disciplines included in the national team in order to provide for a corps of trained personnel to take over these important responsibilities in as short a time as practicable. Additional numbers of Tunisians also should be given advanced training in these disciplines to provide for the specialized manpower requirements in these and other irrigation project areas. The need to supply such technical disciplines from foreign sources should decrease progressively over the next five years due to the proposed training and on-the-job experience of the Tunisian technicians and the planned build up in the GOT educational system plus the return of selected technicians sent abroad for special training.

The relatively limited distances and good roads in Tunisia should permit the national group to serve as consulting and back-up technicians to specific irrigation project personnel.

To accelerate the availability of trained Tunisian personnel for organizing and administering agricultural cooperatives in the irrigation projects, proven managers and technicians could be drawn from existing successful production and servicing cooperatives in Tunisia. Other possibilities for providing the new co-ops with managerial expertise would be to seek out the most promising Tunisian graduates of Universities and agricultural schools as well as the more successful monitors from established irrigated areas.

This proposed group of 9 technicians does not include all of the disciplines that will be required nor all that was requested by certain GOT officials. However it does include the principal skills needed to advise and train GOT technicians in irrigation project development, organization and operation. The proposed resident national headquarters group should be from an organization with substantial back-up technical resources available on call for short time, specific problem assignments. For example, such temporary problem-solving requirements might be for a forester, pathologist, entomologist, or veterinarians.

This national headquarters group would be expected to concern itself as much with forward planning as with problem-solving and training. They would be expected to keep informed on the progress, development and operation of each project and contribute to the plans for additional irrigation projects. They should continually re-appraise the current and

prospective technical manpower needs project-by-project. In so doing they should investigate the utilization of a project as an on-site training and testing ground. Presumably this would be the most advanced project for it is most doubtful that the several projects will move forward at an equal rate in development and operation.

The length of time required for members of the national headquarters group to remain in Tunisia would, of course, depend on the rate of progress in developing the irrigation projects and getting them into successful operation, and on the availability and development of trained Tunisian technicians. In general it is anticipated that services of the Irrigation Engineer, Soil Scientist, Range Management Specialist and the Cooperative Specialist would be needed for at least three years. The Agricultural Economist, Horticulturist, Livestock Specialist and the Team Leader would be needed for about five years. After these periods, it is anticipated that there could be a significant reduction in the requirements for such external technical assistance.

THE FOUR IRRIGATION PROJECTS

As indicated in the introduction of this report the irrigation survey team was concerned primarily with the agricultural land-water development in four areas: (1) a 50-well program, for which it is hoped to provide water to irrigate approximately 3,500 hectares; (2) the El Haouaria project, to irrigate from 650 to 875 hectares; (3) the Oued Nebaana project, approximately 5,200 hectares; and (4) the Upper Medjerda project, which would provide for irrigating approximately 5,000 hectares. The planning and development of these four projects were found to be in varying degrees of advancement. The engineering aspects had proceeded far in advance of other aspects of planning and analysis. The physical and climatic conditions vary substantially in the different areas, and the production potentials also differ widely. Some of these factors as well as the survey team's appraisal of the needs for skilled personnel, organization and training requirements are discussed in the following project by project reviews.

The following summary table indicates the foreign technicians which are recommended for each of the individual projects, the El Haouaria, Oued Nebaana, and Upper Medjerda, discussed in the following sections. It should be noted that the table is by project and does not show a "total" number of technicians. This is intentional, for while these skills are recommended for each project it is most unlikely that all phases of development will take place on all three projects simultaneously. Therefore, there should be many opportunities for one technician to serve on more than one project during the five-year development period. This, plus the fact that only part of the indicated technicians would be needed in the early and closing stages of development of each project, should substantially reduce the number required on duty at any one time. The national center group should assume responsibility for such work assignment scheduling as a part of its overall irrigation support activity.

Positions	El Haouaria	Oued Nebaana	Upper Medjerda
Agricultural Engineer	X	X	X
Agronomist	X		X
Animal Husbandman			X
Cooperative Specialist	1/	X	X
Extension and Marketing Specialist	X		X
Farm Management Specialist		X	X
Horticulturist	X	X	X
Range Management Specialist		X	X
Soil Scientist	X	X	X

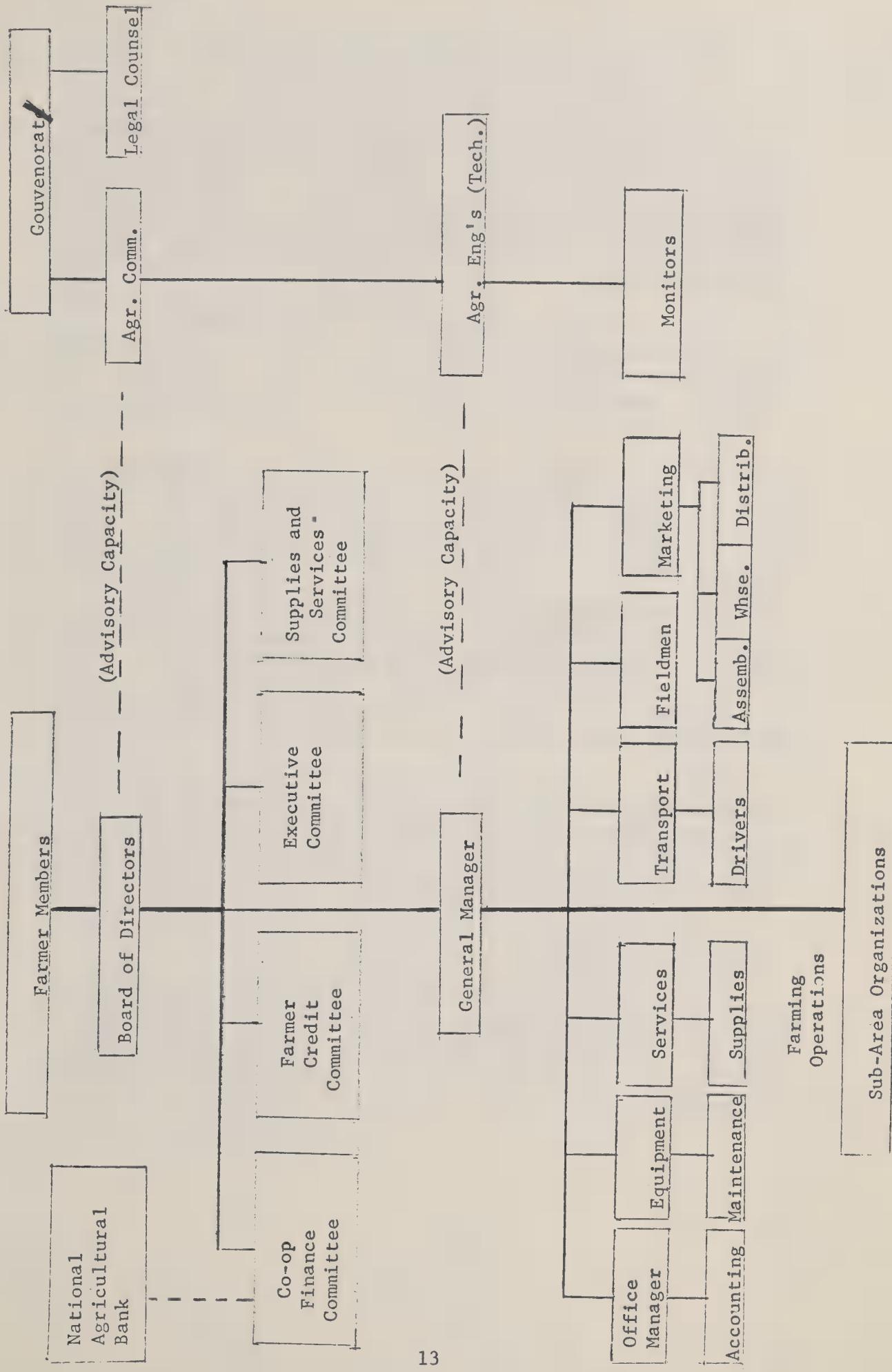
1/ Handled by National Group Member



Organization of project areas - The main center of the project could contain the central administrative organization's offices, banking and credit facilities, machine and motor pool facilities, supply depot, storage and marketing activities. This center would serve as the administrative and training center for the entire project, offering facilities for conducting demonstrations and other activities connected with training and would provide supervision and administrative direction of the several sub-centers organized for most efficient operation.

During the early stages of project development and operation in the traditional non-irrigated areas one trained monitor may be needed for each 20 settlers. Gradually, however, as both the monitors and farmers learn irrigation farming techniques the monitor's activities could be expanded to 40 families, and ultimately to one monitor per 100 families. Trained monitors should be placed in their areas as soon as they have the knowledge, know-how and desire to be of satisfactory assistance to new families starting out.

Example of a Project Area Organization



FIFTY-WELL PROGRAM

Available geologic information indicates that Tunisia has quite extensive ground water resources which ~~are~~ largely undeveloped at this time. In order to accomplish the orderly utilization of this valuable resource, AID and GOT signed ~~an~~ agreement ~~on~~ May 30, 1962 providing for the drilling of 50 water production wells in widely separated areas throughout Tunisia. The primary purposes of this well-drilling program were to provide:

- (1) On-the-job training of Tunisian engineers and well drillers.
- (2) Demonstration of modern well-drilling and development techniques.
- (3) Water for about 60,000 people and for irrigation of about 3,500 acres of land.

In July 1963, the Ralph M. Parsons Company contracted to execute the program. Eighteen wells have been completed of which 12 are for irrigation use (5 are in the El Haouaria project, 5 in the Upper Medjerda project, and 2 associated with the Oued Nebanna project). Two of the remaining wells supply water for Sousse and Sfax and the remainder were salty or dry.

In the Four Year Plan the GOT contemplates the drilling of 400 additional wells.

While exploratory work and data collection ~~are~~ not listed ~~as~~ major objectives in the original program, it is apparent that much information is being made available ~~as~~ a result of this work. A good example is the Upper Medjerda Valley where it is probable that a complete change in the original plan for development of the valley will be made ~~as~~ a result of information now being obtained from the wells drilled ~~as~~ a part of the 50-well project.

As ~~an~~ example of the cost of pumping water from wells developed under the program, the cost records of Oued Meliz Well No. 2 were checked. This well which cost approximately \$29,000 and discharges 1,800 g.p.m. against a head of 108 feet,

should deliver water at a price of approximately \$5.00 per acre-foot. When compared to typical pumping costs in the U. S., this would be considered a very good price.

Much ground water data is now being collected throughout Tunisia. In addition, the 50-well program and the ground water studies in the Upper Medjerda are providing good data. A national program of ground water studies including the analysis of recharge and discharge, and the installation of observation wells, water-level recorders, etc., on a national basis is also being carried on by the GOT to provide data for use in guiding future ground water development.

Water Quality - In general, the quality of water being obtained from these wells is very good and is being utilized for domestic purposes in many cases. The general quality seems to be better than the surface water.

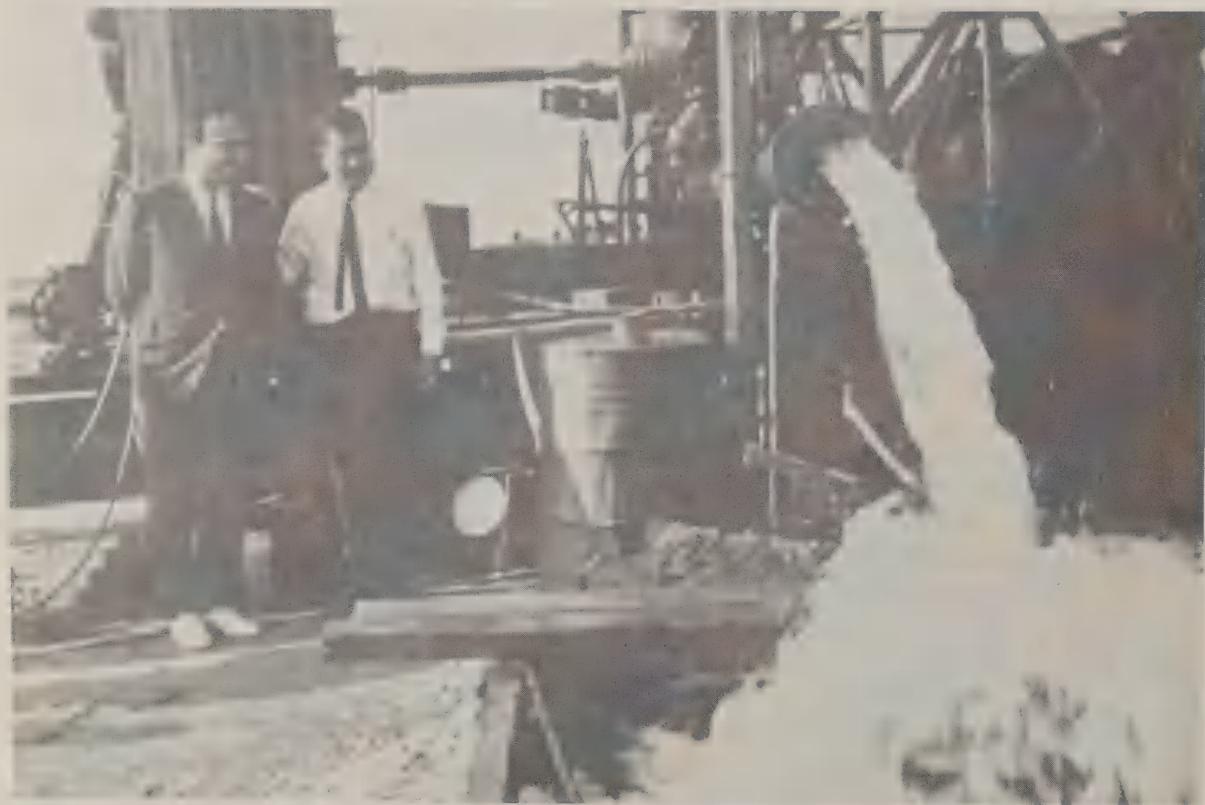
Recommendation - It is recommended that all land to be irrigated from the wells, especially that not a part of a major irrigation project, be properly mapped and classified for irrigation development, so that the water will be most effectively used and applied on those soils and crops that will give maximum benefits.

Program Manpower Requirements - The 50-well program presents different technical manpower requirements problems than the other three irrigation projects discussed in this report. The wells in this program will be in widely separated areas of Tunisia, and several will be situated within the other project areas. Many of the 50 wells are not yet drilled and their final location undecided.

Moreover, one of the purposes of the project was to train Tunisian drilling crews since the GOT hopes to expand the well drilling activity ten-fold. The land conditions and utilization of the water from these wells has, and of necessity will, vary substantially.

All irrigation projects have essentially similar problems in the needs for their development, organization and operation and the need for attention to the associated dry-land crop production areas and adjacent grazing areas. Most of such problems vary chiefly in magnitude, depending on whether the project is a multiple-well project or a single-well operation. Therefore, no attempt was made by the study team to evaluate the manpower requirements, technical or otherwise, for the individual wells in the fifty-well program.

On-the-spot counsel and guidance by the national technical group, together with the knowledge of the Tunisians gained through long-time experience with the operations of the traditional oases plus the recent experience of such one-well irrigation operations as the FAO experiment station near Sidi Bou Zid (the Ouled M'Hamed Experiment Center) should provide excellent guides to the man-power needs of these small, disbursed irrigation well projects. It is suggested that the operation of the FAO irrigation project be given special study in this regard. This is a one-well irrigation development in a region of non-irrigated land in which there had previously been little if any cultivation. That one-well project has been established within the past few years. In its origin, a tribe of 245 families owning about 3,500 hectares of arid land turned over to FAO for irrigation and for other experimental purposes 1,750 hectares, of which ~~more~~ than 60 hectares are now under part-time irrigation and about 40 hectares under year-round irrigation.



Lassad Ben Osman, Chief of Hydraulics Engineering Service, GOT, and R.L. Winters, Director of Agriculture Division, USAID/Tunis, at producing well.

EL HAOUARIA PROJECT

The El Haouaria project embraces a large plains area south of the village of El Haouaria on the tip of Cap Bon. Because of the topography and flat slopes, the natural drainage system of the plain was not adequate to carry off flood flow. Originally, therefore, the plain was occupied by a large fresh water lake (Garart el Haouaria), which varied in size depending on rainfall, inflow and evaporation. In addition to the area actually inundated, much of the adjacent plains area was unusable for farming because of a high water table. During the period 1958 through 1962, a surface drainage system was installed which largely eliminated the lake and lowered the water table to such an extent that much of the land could be farmed. Because of the low amount of precipitation in the area during the growing season, irrigation is required for crop production.

At present the irrigation supply is from shallow dug wells, producing small quantities of water. Much of this water is highly saline. The agricultural development of this plains area is severely limited by the inadequate quantity and quality of existing irrigation water supplies. Agricultural production also is restricted in many parts of the general area by the presence near the surface of an impermeable calcareous layer which, upon irrigation may result in a perched water table. These sites are being eliminated from the proposed irrigated areas.

The objective of the El Haouaria project as proposed by the Tunisian Government is to expand the agricultural production of this plains area by development of a firm supply of good quality irrigation water from deep wells and at the same time improve drainage conditions.

Selection of the two areas to be irrigated was based on a series of soil surveys by GOT and I.E.C.O. Although these areas include the better quality lands available in the project vicinity, they are nevertheless marginal for irrigation development. The reasons for this are:

1. Potential drainage problems.
2. Presence of a calcareous crust within the soil profile.
3. Topography making water distribution difficult.
4. Intermittent areas of shallow soils and sandy soils of low water-holding capacity.

Agriculture of the area - Nearly all of the perimeters selected for irrigation have been farmed with varying success in the past. Some of the crops that have been tried were small plantings of pepper, tomato, cantaloupe, watermelon, potatoes, maize, wheat and barley. In addition, there ~~are~~ very small plantings of fruit trees including pomagranate, olive, fig and orange. Recently, small plantings of peanuts were said to have been tried on the sandy area with ~~somewhat~~ success.

Present plans of the Government call for the irrigation of two areas. The larger of the two areas is called "Dar Chichou," which is subdivided into four sections designated A-D.

In Section "A" there are 175 hectares of land proposed for vegetable production and 30 hectares proposed for tree fruit crops. A sprinkler system is planned and wells are drilled or planned for irrigation water for this section in the near future.

In Section "B" the proposed cropping plan is for 140 hectares of vegetables. The presence of a calcareous layer at one to four feet depths and a potential drainage hazard have indicated the need of percolation rate studies which ~~are~~ now in progress.

The Sections "C" and "D" ~~are~~ similar to Section "B" and final decisions will not be made until the percolation and drainage studies ~~are~~ completed.

The other area considered for irrigation is called the "Coastal Zone." In this area, 105 hectares ~~are~~ proposed for vegetable production and 190 hectares for fruit tree production, principally citrus.

Some of the limitations in these two areas, such as drainage problems, the presence of a calcareous crust, difficult topography and ~~areas~~ of shallow soils have already been mentioned. In addition, there are other limitations such as very strong winds that will require the establishment of sturdy and tall windbreaks. Also the production of citrus on the deep sandy soils will require frequent light irrigation applications and the addition of considerable fertilizer including minor elements. A further and very important hazard to profitable production of citrus is the presence of the Mediterranean Fruit Fly. During inspection of a small planting, the farmer observed that it was difficult to harvest oranges because of fruit fly infestation, although he did indicate that lemons were no so severely infested as the oranges.

With respect to irrigation and drainage, it is planned to irrigate the El Haouaria project with sprinklers. This type of irrigation is well adapted to the sandy and shallow soils, and undulating topography found in this area. The primary hazard connected with the use of sprinklers, is the high wind velocities that may be encountered during the growing season. The numerous windbreaks that are planned are needed in order to obtain reasonable water application efficiencies. The wind velocities and frequency of occurrence should be carefully considered before arriving at final design efficiencies or planning the number of hours of operation per day.

From the standpoint of the El Haouaria irrigation project, livestock production is not a major consideration. The project area is near the tip of the peninsula and the agriculture there is not conducive to expanding livestock production. To the extent that a balanced cropping pattern is put into effect in the irrigated area there should be some increase in the feed supply for the existing livestock population.

Current Status and Development - At present there are five wells completed in the El Haouaria area to supply water for irrigation. All of these wells were developed as a part of the 50-well project. Measurements of the existing wells indicate that approximately 30 to 35 liters of water per second (480-550 GPM) will be available from each well. The data available on the five wells indicates good quality water of less than 750 p.p.m. The immediate GOT plans are to irrigate 500 hectares by 1968. If fully developed it is planned to irrigate 875 hectares which will require an estimated 21 wells. The further development of this marginal area for irrigation should be dependent upon the results of current studies being made by the GOT and reviewed by the International Engineering Co.

There is a small plot of ground set aside for a demonstration or plant propagation station that has recently been placed under the jurisdiction of the Gouvernorat. We understand that a monitor and a guard have been placed in charge and there is a building on the grounds. If the area is to be developed for irrigation, there is certainly great need for a station to study adequate windbreak establishment and advise farmers as to cropping methods, fertilizers, and water application on each of the soil types. Also, where fruit trees are to be a principal crop there is need to consider what crops could best be grown to support the farm family until the fruit trees come into production. These problems merit immediate attention.

Recommendations

1. It is strongly recommended that the present small horticulture station at El Haouaria be expanded. There is great need for development of horticultural practices suitable for both the very heavy and the very sandy soils.

2. The planting of oranges, apricots or peaches in this area should be developed at first in test plantings to gain experience because of the potential handicaps due to the Mediterranean Fruit Fly depredations and the strong winds.

3. The water table and drainage survey, as requested in the IECO 1963 evaluation report, is needed and should be accomplished in order to show the drawn-down effect of the existing drains and provide a basis for future design of the drainage system and the selection of crops.

4. The high wind velocities that may occur during the growing season are a primary hazard connected with the use of sprinklers for irrigation. The winds are also detrimental to plant growth and production. It is recommended that the wind velocities and frequency of occurrence now being studied to determine wind effects on sprinkler patterns on specific crops be continued.

Project Manpower Requirements - The Cap Bon area is one of the most developed agricultural areas in Tunisia. Many of the farmers there are skilled in the production of fruit and vegetable crops and are familiar with the use of irrigation techniques. Therefore, there should be a great reservoir of irrigation farming know-how within the agricultural professional staff working in the area as well as practical experience among the farmers.

Unfortunately, the El Haouaria area, near the tip of the Cape, is outside the established production area. However, this nearby familiarity with irrigation techniques and the nearby established supply and marketing facilities should simplify the governmental role in the actual settlement and operation of the project.

The team is encouraged to find that the Tunisian technicians have recognized the physical limitations of the area and are taking serious steps to check on such matters. Therefore, once the current investigations as to permeability, wind velocities, and similar limiting factors are completed and the specific areas for development are chosen, the actual land settlement, organization, producer training, and governmental support and direction

should be relatively simple. To a large extent this should be within the technical capabilities of the local officials and due to proximity of the proposed national group located in Tunis, it would appear that only limited foreign residential technical support would be needed, and that for a relatively short period of time.

A larger cadre of technicians would be needed during the development and initial operation of the project than later. While irrigation farming is not new to many of the people in this general area, sprinkler irrigation is new, so an Irrigation Engineer would be required during installation and initial operation. It is estimated that an Agricultural Engineer, a Soil Scientist and an Extension and Marketing Specialist, resident in the area, would be required during the first two to three years of the project. A Horticulturist and an Agronomist would be needed for a longer period during which time they should also be associated with the experiment station in the project area. Guidance and counsel in the organization and conduct of the cooperative could be provided by the Cooperative's Specialist with the national technical group since the project area is relatively close to Tunis. Of course, Tunisian counterparts should be assigned to the above technicians during the period of their residence on the El Haouaria project. This should suffice in light of the general Cap Bon area experience referred to above.

The resident staff of Tunisians at the project center should include the following positions:

<u>Professional or Sub-Professional</u>	<u>Other Positions</u>
General Manager	Secretary
Office Manager	Equip. Maintenance & Mechanics
Counterpart Irrigation Engineer	Transport drivers
Counterpart Soil Scientist	Farm machine operators
Extension and Mktg. Specialist	Warehouse labor
Bookkeeper	Other semi-skilled labor
Equipment Supervisor	
Farm Supplies and Warehouse Supvr.	
Monitors	
Fieldmen	

To the extent that settlement is concentrated in different locations it may be desirable to organize operations of the project into sub-centers, the number of which would depend upon the number of such concentrations. This would require at least a minimum staff at each sub-center, including an assistant general manager, bookkeeper, monitors, fieldmen and personnel to handle supervision and operation of the sub-center.

OUED NEBAANA PROJECT

The Oued Nebaana Project was originally planned to supply water for urban as well as agricultural use. This plan has been changed and it now will supply only irrigation water and provide a degree of flood control. The Sidi Messaoud Dam on which construction is nearly completed will be the primary source of water. This water will be supplemented by pumping from wells in the Bled Sisseb. An extensive pipeline delivery and distribution system of approximately 219 kilometers in length (136 miles) will transport the irrigation water. GOT plans call for the pipeline construction to be completed by December 30, 1968. This may be an optimistic target date.

The agricultural development in the Sahel area originally included seven separate areas. It now includes 10 areas located in a narrow strip approximately 70 kilometers long near the Mediterranean coast, lying on both sides of the town of Sousse. The area changes have been made to improve the drainage and meet socio-economic objections. The development of this area is planned for completion by January 1969. Most of this area is now privately owned and used for olive and vegetable production. This project was proposed primarily for the production of early vegetables for sale in Europe. It is now planned to plant 2,042 hectares to apricots, 1,311 hectares to vegetables and 621 hectares to citrus. The apricots and citrus will gradually replace old olive plantings.

The irrigation project in the Sbikha area is about 12 kilometers southeast of the Sidi Messaoud Dam and is primarily government-owned land in what has been a pasture and small grain area. When irrigation water becomes available this area is to be utilized for apricots (852 hectares) and limited (324 hectares) citrus production. The development of this area is planned for completion by July 1968.

Soil and Land Classification - Reconnaissance soil surveys have been made on both the Sahel and Sbikha areas; the Sahel in 1959 on a scale of 1:50,000 and the Sbikha in 1957 using a scale of 1:20,000. French pedologists, using the same legend, did the field work in both cases. The two surveys provide similar information. Both surveys are well done and dependable insofar as can be expected of reconnaissance surveys; however, there is a need for detailed surveys on which to base land use and final project settlement plans.

The IECO evaluation report adequately points out some of the problems connected with soils in the various areas selected for irrigation. A few of the areas planned for irrigation have been surveyed at a scale of 1:10,000 and seem adequate. We are pleased to note that the GOT is recognizing the need for more detailed surveys where the soils are complex. We observed that in two cases the survey was on a scale of 1:5,000 in one instance and 1:2,000 in another.

Poor drainage has been somewhat of a problem in selecting the lands to be irrigated. In the Sbikha area, 624 hectares of an original 1,800 have been dropped from the project because of poor drainage. Another small area where drainage problems may become critical is now being studied. The Team members feel that such detailed drainage studies are most important.

Water Quality - The water quality studies quoted in the evaluation report indicate dissolved solids up to 2,000 p.p.m. with the sodium content low enough that serious problems are not anticipated. One test during low water flow indicated the possibility of some water of poor quality that could affect crop production and soil structure in the fine textured soils. This should receive further attention.

Livestock - Livestock are not likely to be important recipients of benefits to the specific localized spots considered for irrigation in the Oued Nebaana project. The water development will, of course, have some influence on feed produced, but over a time the greatest priority for the water is likely to be for fruit and vegetable crops rather than forage.

Recommendations - Sbikha Area - The proposed cropping pattern for this area at present includes only 852 hectares of apricots and 324 hectares of grapefruit. An initial venture began in 1949 when a cooperative involving 17 "homestead farms" of four hectares each were planted with some 7,000 apricot trees. It was not possible to visit these plantings but they were reported to be satisfactory. It is recommended that a horticultural and agronomic experiment station be established very soon in this area. This should help guide the farmers as to what economic crops can be grown prior to the time that the fruit trees come into production. The problem of possible losses due to the Mediterranean Fruit Fly should also be given attention.

The Sahel Area - Of the 10 currently proposed areas in the Sahel irrigation project, it is urged that only the best areas be considered for irrigation. The final cropping pattern of each such selected site should be based upon the experience gained at the four horticultural and agronomic stations located in the area as well as the experience of successful local farmers.

Project Manpower Requirements - The complexity of the Oued Nebaana project, incorporating plans for irrigation from the Oued Nebaana Dam plus use of ground water from wells, a lengthy distribution system for the water and the land to be irrigated in more or less scattered or fragmented pieces in both the Sbikha and the Sahel, creates difficult problems in estimating technical manpower requirements for this project. It was recognized that maintenance and operation of the dam and its distribution system will require manpower, as will the watershed protection and grazing control measures associated with the Oued Nebaana area. This aspect of the problem was not included in the team's assignment. However, these manpower requirements must be considered in the overall development and operation of the Oued Nebaana irrigation project.

In general, the technical manpower requirements for the Oued Nebaana project are much the same as for the El Haouaria project, discussed above, with one major difference. The Sahel area is similar in that it is adjacent to and a part of a well developed agricultural area made up of private land owners who have been practicing irrigation for some time. Therefore, there are social attitudes and operating production and marketing institutions available to service the added area. Also, there are the four horticultural and agronomic stations already mentioned. These items which include going cooperatives with experienced staff and membership should, with limited outside assistance, be able to serve the new areas as rapidly as they are brought into production. However, these factors do not exist in the Sbikha area so a project team of external technicians and Tunisian counterparts as listed below, would be needed to help with the development, organization and initial operation of that portion of the irrigated area. These technicians would also be available to work with the existing organizations and officials as needed in the Sahel (Sousse) area.

Non-Tunisian technicians needed on the Oued Nebaana project until the project is established and operating should include an Agricultural Engineer (irrigation and drainage), a Soil Scientist, and a Cooperatives Specialist. Additional technicians would include a Horticulturist, and a Farm Management Specialist, both of whom should be available for perhaps three to five years after the project is in operation.

While the present plans do not appear to include integrating the irrigation area with the surrounding grain and livestock grazing lands, the team hopes this would be accomplished; if such integration is adopted a Range Management Specialist should be added to the cadre of technicians resident in this area for a three to five year period also.

As indicated for the other projects, it is important that Tunisian counterparts be assigned to work with the above

technicians during the period of their assignment on the Oued Nebaana project.

The staff of Tunisians for the project center should also include all essential positions for effective administration and operation of the irrigation project. To the extent that experienced and qualified personnel are available in the present organizations operating in the Sousse area many, if not most, of these positions could be filled by such persons. The following positions would be the minimum necessary for effective and efficient operation of the Oued Nebaana project center:

<u>Professional and Sub-Professional</u>	<u>Other Positions</u>
General Manager	Secretary
Office Manager	Equip. Maintenance and mechanics
Counterpart Agricultural Engineer	Transport drivers
Counterpart Soil Scientist	Farm machine operators
Counterpart Horticulturist	Warehouse labor
Counterpart Cooperatives	Other labor
Specialist	
Counterpart Farm Management	
Specialist	
Counterpart Range Management	
Specialist	
Bookkeeper	
Equipment Supervisor	
Farm Supplies and Warehouse	
Supervisor	
Monitors	
Fieldmen	

Owing to the scattered nature of the lands to be irrigated in the Oued Nebaana project there will need to be several sub-centers to efficiently provide services and supplies to the several concentrations of farmers in the Sbikha portion of the irrigation project. To the extent that such sub-centers are organized there will be required at least a minimum staff at each sub-center, including an assistant general manager, bookkeeper, and skilled personnel to handle supervision and operation of the sub-center.

UPPER MEDJERDA PROJECT

The project area is situated in the Upper Medjerda Valley which encompasses an area of approximately 14,000 hectares. The Upper valley extends about 7 kilometers in a north-south direction and 20 kilometers in an east-west direction. It is divided into three parts by the oueds Medjerda and Rarai, which have their confluence near the Oued Maliz village. The valley comprises about 6,200 hectares north of the oued Rarai, 3,700 hectares between the rivers and 4,100 hectares south of the oued Medjerda.

The feasibility report for the development of the Upper Medjerda project, as prepared by IECO for AID, was based on the storage of surface water in constructed reservoirs with diversion dams in the river channel to direct the water into the canals serving the irrigated areas. Four dam sites were investigated with two still being considered feasible.

Subsequent studies have revealed that ground water is available in this area and a comprehensive survey is now under way to define the ground water resource that is available in the area for irrigation use. The contract between AID and IECO has been amended to include the preparation of a revised feasibility report which will analyze the complete water situation in the upper valley considering the utilization of both surface water and ground water or a combination of the two.

Presumably the extent of future development will be based on the recommendations contained in this revised IECO report when it is completed.

Five well sites have been selected in this project area and drilling is now in progress as a part of the 50-well program. Preliminary estimates indicate that the utilization of ground water will give a more favorable cost-benefit ratio than was obtained by the use of surface water alone.

The IECO report shows that a land classification system similar to that used by the Soil Conservation Service, U.S. Department of Agriculture, was made. The lands classified II through IV are irrigable; Classes III and IV are subdivided to provide more detail. The soils run to clay loams with permeability ranging from slow to moderate, and clay soils from slow to very slow permeability.

Soils of both Class II and III are suited for general crops, with preference given to Class II areas which are more easily managed. Class III-3 and III-1 lands may be preferable for tree crops. The soils in Class IV will be difficult to manage under irrigation and should be avoided.

Agricultural Production - Because of the favorable soil, climate and topographic conditions, the Upper Medjerda area is well suited to production of food crops under irrigation. Almost all the cultivated lands ~~are~~ presently used to produce small grains, principally wheat. A supply of irrigation water to about 5,540 hectares of project lands would increase both cropping and yields, thereby improving the agricultural economy; provide a rich diversification of foodstuffs for diet improvement, and supply crops for export to acquire foreign exchange. Thus, in addition to the direct calculable benefits to the farmer, employment opportunities will be provided in related transportation, processing, merchandising and retailing services.

The provisional cropping plan recommended 20 percent citrus (1,000 hectares) and 80 percent (4,000 hectares) in a four-year rotation of sugarbeets, forage, vegetables and cotton. The current use of non-irrigated land includes principally wheat, olives, forage and tobacco. About ~~80~~ percent of the cultivated land in the valley is presently utilized for growing small grains. The soils of the Upper Medjerda are good and capable of producing a variety of crops.

Frosts and relatively low temperatures may have an influence limiting the production of very early vegetables but should not detrimentally influence production of mid-season vegetables. Frosts may also cause some damage to citrus blossoms, and occasionally to fruit and leaves, but is not expected to cause extensive damage to fruiting wood. The citrus trees observed in the area showed no extensive wood damage even though snow was reported to have fallen in the 1964-65 season.

At the pilot farm, "Chemtou," there were test plantings of apples, pears, quince, and prunes which were introduced from France. This is an excellent example of the proper use of a test planting station. There was also a small planting of citrus. The results may very well help to decide whether it might not be more desirable to modify the cropping plan to use fruit trees other than citrus. At least these things can now be given some definite considerations because of the fact that test plantings have been made. Such tests should be expanded to determine different methods of tree culture; that is, free-growing trees where total fruit production would be greater than on trellised trees where production would be lower although individual fruit quality might be somewhat higher. There should also be an extension of tree variety and fertilizer tests.

In addition to the irrigated portion of the Upper Medjerda, the upland should be so handled that there is an opportunity to practice good soil and water conservation. The woodland areas should be protected from grazing. The pasture or grazing lands are presently overgrazed by sheep and cattle. It is our understanding the goats have been eliminated in the area, and this is good. A system of controlled grazing should be established so that native vegetation has an opportunity to survive and furnish more feed for livestock. Proper use of or the regulating of grazing is absolutely essential if more and improved quality livestock products are expected.

Tabias or terraces on the sloping land, properly spaced, will provide both erosion control and water retention. It is believed that the Tunisians appreciate this for some good conservation work has been started on a small area using terraces and controlled grazing on pasture and range adjacent to the irrigated areas of the Lower Medjerda Valley development.

The Upper Medjerda project holds important implications for improvements in the livestock industry of Tunisia. Nearly 40 percent of the cattle in Tunisia are in the three governorats in and immediately adjacent to the proposed irrigation project area (Souk El Arba, Le Kef and Beja). One-eighth of the nation's cattle are in the Souk El Arba governorat alone.

Only about 4 percent of the total sheep population of Tunisia are in the Souk El Arba governorat, but the adjacent governorats are important in sheep production. The three areas combined account for around one-fourth of Tunisia's sheep.

Water Quality - Preliminary laboratory analysis of the water of the upper portion of the oued Medjerda and tributaries indicates that this surface water is usable for irrigation on the soils to be irrigated. The quality of water obtained from pumping the four wells now completed indicates that high quality water varying from 400-1200 p.p.m. salinity can be obtained from ground water.

Regardless of the source of water -- surface, ground water, or both -- it is apparent that the water quality downstream from the Upper Medjerda project will ultimately be affected by the drainage from the irrigated areas. Since water quality is a critical problem on the Lower Medjerda irrigation project, it is important that the effect of this drainage water on the overall salinity of the water in the oued Medjerda basin be observed and analyzed with a view of planning any remedial measures necessary.

Drainage - Investigations by International Engineering Co. indicate that sub-surface drainage will not be a major problem

except in those areas where Calss IV land may be irrigated. Topography is such that adequate outlets can be obtained for both surface and sub-surface drainage.

Adequate surface drainage systems must be included in the plans for the irrigated areas since the average annual rainfall is 449 mm (17.7 inches), and the water disposal systems must be large enough to dispose of the runoff from rainfall as well as the surplus irrigation water.

Land Development - The plans for land development and layout of the irrigation systems should provide for erosion control from rainfall as well as the efficient distribution of irrigation water.

Irrigation with the small basins constructed by hand, as now generally used, requires only a minimum of land leveling. It should be kept in mind that if a conversion is made to the use of tractors and larger fields, more land leveling will be required in order to obtain good water application efficiencies. The steeper slopes of one to two percent should be leveled in benches to conserve rainfall and control irrigation water. Bench widths should fit the widest multiple-row farm equipment expected to be used.

Irrigation Distribution System - The water requirement data supplied by the International Engineering Company appears to be reasonable and should provide a sound basis for estimating the required capacities of the distribution system. Typical plans prepared by GOT for other projects in Tunisia were studied and it is understood that a similar approach to distribution system layout will be used in the Upper Medjerda. The design of the distribution system is also primarily controlled by the acreage allotted to each farmer, which is now planned to approximate 5 hectares.

Recommendations - 1. The provisional cropping pattern will undoubtedly be modified if wells are to become the principal source of water in the area. It is likely that vegetable crops will be emphasized. In considering citrus as a principal crop the hazards of possible cold damage and the resulting fluctuations in yields from year to year should be given consideration. This factor, as well as the probable substantial fruit loss associated with the presence of the Mediterranean Fruit Fly (reportedly 40 percent during the past year), indicates that consideration should be given to the potential production of cold-hardy tree crops, such as cherries, pears, and apples.

2. The Upper Medjerda project is especially important to livestock as a potential for substantially increased feed availability on which an expanded livestock and poultry industry can be achieved. With the wide seasonal variation that now exists in feed supplies in Tunisia, it is important that this potentially

productive area be utilized to increase livestock feed output to the maximum practical extent. This includes not only increased forage production in the irrigated area but also the pastures and grazing lands in and adjacent to the irrigated area. A balanced production of feed as well as food crops on the irrigated lands, plus improving the grazing and forage on the non-irrigated land, can make a major contribution to this area.

Project Manpower Requirements - As indicated earlier in this report, the Upper Medjerda project has a good potential for land-water development and irrigation operations. It also has a good potential as an on-site training ground for non-technical manpower requirements not only for the project itself but also for the other irrigation projects in Tunisia. One advantage is the relatively nearby and similar climatic conditions of the Lower Medjerda development project where there are several established cooperatives with trained and semi-trained individuals. These experienced, nearby facilities could serve as a visual pattern, temporary training ground and perhaps provide some experienced personnel to help guide the Upper Medjerda project in the selection and training of the farmers in irrigation farming practices and the use of cooperative facilities.

The Upper Medjerda project is to be developed in stages as water becomes available and it now appears that this area will be the first to actually start production. If this assumption is correct there should be a number of advantages to the total land-water development in Tunisia if this project area also is used as a manpower training "laboratory" for on-the-job training of personnel for the other irrigation projects. If this course of action is taken the number and duration of on-site technicians needed might be somewhat greater than if the personnel to be trained are limited to only those needed as the single Upper Medjerda project grows.

National guidelines and overall technical assistance would come from members of the national headquarters group of technicians. Members of that group would spend a portion of their time in support of the resident staff in the planning, development, organization, and initial operation of the Upper Medjerda project. The external technicians resident in the Upper Medjerda project should include the following specialties or disciplines:

Cooperatives Specialist

Animal Husbandman

Agricultural Engineer

Farm Management Specialist

Horticulturist

Extension and Marketing Specialist

Agronomist

Range Management Specialist

Soil Scientist

This team of non-Tunisian specialists should be backed up by Tunisian counterparts for each specialization as follows:

Counterpart Agricultural Engineer
Counterpart Soil Scientist
Counterpart Range Management Specialist
Counterpart Agronomist
Counterpart Horticulturist

The length of time the external resident specialists would be needed would depend upon the rate of progress in getting the full project area under operation, and the extent of the training program undertaken. A period of about four years should be anticipated. Should the project be utilized as a training ground for the other projects a longer time would undoubtedly be required for certain disciplines.

The manpower requirements for administering and operating the project center, in addition to the Tunisian counterparts who would work with the team of external specialists, would be similar to those listed for the El Haouaria project. The resident staff of Tunisians at the project center should include the following positions:

Professional or Sub-Professional

General Manager
Office Manager
Bookkeeper
Equipment Supervisor
Farm Supplies and Warehouse Supv.
Monitors
Fieldmen

Other Positions

Secretary
Equip. Maintenance & mechanics
Transport drivers
Farm machine operators
Warehouse labor
Other simi-skilled labor

In view of the greater size of the Upper Medjerda project there will need to be a greater number of monitors, fieldmen, transport drivers, farm machine operators, and other labor than for the smaller projects.

NATIONWIDE IRRIGATION PROJECT PLANS

The Government of Tunisia is doing much more in water development than the four irrigation projects the Team was asked to review. The following table does not include extensive efforts to improve urban water supplies but does indicate the scope of the irrigation effort.

Sponsor	:Existing:		In Process:	Proposed:	Total Acres
	: Acres	: Acres	: Acres	: Acres	: Acres
Non Government :	:	:	:	:	:
(private tribal:	:	:	:	:	:
wells, oases, etc.)	: 37,686	: ---	: ---	: 37,686	
GOT Resources only	: 2,250	: ---	: 71,661	<u>1/</u>	73,911
GOT plus Foreign Assistance, U.S:	43,450	77,000	---		120,450
Other	: ---	: 34,250	: ---		34,250
Total	: 83,386	: 111,250	: 71,661		: 286,297

1/ Based on GOT Estimates, in Four-Year Plan

In light of the magnitude of the irrigation work underway and planned at the present time, the varying speed with which each can be expected to proceed and the undesirability of trying to do too much too soon, it is difficult to anticipate the exact manpower requirements by individual projects. However, a balanced program of irrigation development presupposes a series of concurrent activities. Otherwise the water will be developed and even delivered to the farm boundaries without adequate information or facilities available for its proper use.

The Team had the ambitious national irrigation effort very much in mind in suggesting the nine-man national center group of technicians and in stipulating that this group should have direct access to a wide variety of additional technicians who could be called on for short-term, specific problem-solving support. While the suggested tenure of the national center group is directly related to the development of the four specific irrigation projects with which this report is concerned, it is anticipated that the group could also be available for a limited amount of their time while there for counsel and advise on nationwide water development plans. Should more than a nominal amount of such auxiliary assistance be desired from this national group, it might be desirable to extend the period of their assignment, or at least of those members of the group whose knowledge and experience would be most needed under the circumstances. It should be recognized, however, that such a potential need would depend upon the results of the training activities and Tunisian counterpart follow-through suggested here.

ADDITIONAL OBSERVATIONS RELATIVE TO AGRICULTURAL DEVELOPMENT

Engineering - The consulting engineering services for the irrigation projects that have received U.S. assistance has been done primarily by contract with private engineering firms, such as International Engineering Co. of San Francisco and the Parsons Co. of Los Angeles. Technically, this procedure is working satisfactorily with the possible exception of the counterpart training of Tunisian government engineers.

However, with the present shortage of qualified local engineers the contract approach seems to provide a suitable procedure in order to get high quality work done in time to meet the GOT's plan of development.

Typical plans for land development work, and irrigation layout for such projects as Oued Nebaana, which are prepared in the Hydraulic Division, Ministry of Agriculture, were reviewed and seemed to be well-prepared.

Similar layout work including the proposed surface and sub-surface drainage and land leveling plans should be prepared for the other proposed projects, including the land to be irrigated from each well outside an existing project. This detail work could well be delegated to field engineering offices in accordance with the ability of the engineers concerned, in order to build a trained organization which can handle the design load anticipated in the future.

Mapping - Most of the pedological surveys made are on a scale of 1:100,000, 1:50,000, and 1:20,000. These surveys are good and provide adequate information for broad overall planning. However, more detailed mapping should be done where irrigation projects are contemplated (a few such detailed surveys have been made as referred to earlier in this report). Such surveys should provide the basic information needed for interpretation, land capability classification and planning purposes.

A soil scientist trained in detailed mapping, interpretation and land classification work should be available to the pedological group in the GOT to work with and advise them on up-to-date methodology for mapping, classifying and interpreting.

Technical Guide - There is need for the development of a Technical Guide (Handbook) for Tunisia. This Handbook should provide information regarding the handling of lands that have been surveyed. The soil map should be the basis from which the technical guide is prepared. The guide should provide detailed physical information regarding the soils, suitability for irrigation, the adaptability for certain kinds of crops, etc. In addition, the technical guide should provide information on the kind of treatment necessary to get optimum production of the various crops whether forage, vegetable, fruit, or tree crops.

Mediterranean Fruit Fly - The GOT has successfully carried out a program of expansion of fruit tree plantings and more are planned. Among the crops receiving special emphasis are apricots, citrus and peaches. All of these crops are subject to fruit losses due to the Mediterranean Fruit Fly, Ceratitis Capitata. The current losses due to the fruit fly have been estimated at four to six million dollars annually.

At the Institute National de la Recherche de Tunisie (I.N.R.A.T.) the Entomology Section has developed a relatively good method for rearing the flies. They have tried X-ray sterilization with variable success. They wish to obtain a source of cobalt 60 for male fly sterilization. The possibilities have been discussed as to the role of INRAT becoming a training center for representatives of neighboring countries so that a general program of fly sterilization might be undertaken to control the fruit fly. If and when they do get the source of cobalt 60 they will need training by a specialist in handling the cobalt 60 source and its effective operation. There would also be a need to expand greatly their facilities for mass rearing of the flies and for planning mass distribution of them at the appropriate time. The potential for success of such a program has yet to be tested and proven. Even if a program proved to be feasible and successful, there is no existing guaranteed procedure to guard against reinfestation.

It is suggested that while this program of mass sterilization is under consideration, investigations should be made of chemical control methods such as that developed in Brazil of fruit fly where poison baits

provided a practical control of fruit fly damage (the Fruit Culture Section of the Institute Agronomico, Campinas, Sao Paulo, Brazil).

Fungus Diseases and Other Pests - Cidium infection on wheat was reported to be very serious and there was considerable evidence of the presence of this fungus under field conditions.

Scale infestations on citrus trees and on citrus fruit were observed. Control procedures need to be studied so that spray schedules suitable to Tunisian conditions could be established. The services of an experienced pathologist or entomologist to review the specific situation and recommend control procedures by seasons should be secured and then tested by field trials.

Virus Diseases of Citrus - In a "Survey of Citrus Production in Tunisia," Adriance reported the need for citrus rootstock tests. All of the citrus trees in Tunisia are now planted on sour orange rootstocks and the one and a half million citrus trees being given out to farmers in the four-year program are all budded on sour orange rootstocks.

Tristeza virus has caused the loss of millions of citrus trees on sour orange rootstocks in many parts of the world where citrus fruits are produced. It has been essential in these infested areas to change to the use of tristeza virus tolerant rootstocks. The latter include such potential rootstocks as Cleopatra mandarin, sweet orange, trifoliate orange, rough lemon and rangpur lime.

Initial test rootstock plantings should be made on different soil types at the various horticultural stations in the areas where citrus is to be grown. Sour orange should be used as a control rootstock for comparisons. There should be replicated plots for evaluation of tree growth and production. Great care should be taken in selecting and labeling all budwood sources.

Rootstock tests are essential as a precaution to the possible occurrence of tristeza virus in Tunisia and would lead to a knowledge of what rootstocks are best suited to Tunisian soil and climatic conditions.

Increasing the Livestock Feed Supply - One of the major purposes of water development and irrigation in Tunisia is to obtain increased quantities of livestock feed. Concurrent with this should be a concerted effort to develop potential livestock feeds not requiring irrigation.

Reference already has been made in this report to the desirability of grazing controls as a means of increasing feed production. Another potential source of additional feed that should not be overlooked is the spineless cactus. This plant is productive under semi-arid conditions and can withstand drought conditions for fairly long periods.

Two test plots of spineless cactus, and experiments of its qualities as feed, were observed in Tunisia. One such plot is near Pont du Fayits. Another newer plot in which active research is underway, is at the FAO Ouled M'hamed Experiment Center, Gouvernorat of Gafsa. This station is in an area where the annual rainfall fluctuates from two to eight inches per year. Satisfactory results are being obtained in that experiment with spineless cactus for livestock feed.

In the U.S., spineless cactus has been found advantageous and economic when fed in the green state, being comparable in feeding value to root crops and immature green-corn fodder. It is recognized that cactus is not a complete feed, but would be very valuable in Tunisia in combination with other available feeds. This could be a great advantage to sheep and cattle producers by providing an assured supplemental feed supply.

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PROPOSED LOCATION OF IRRIGATION PROJECTS AND FIFTY WELLS

